

**EFFECTS OF AGING, TEMPERATURE, MOIST
AGGREGATES AND FILLER TYPE ON
PERFORMANCE OF WARM MIX ASPHALT
INCORPORATING RH-WMA ADDITIVE**

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UNIVERSITI SAINS MALAYSIA

2017

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FILLER TYPE ON PERFORMANCE OF WARM MIX ASPHALT
INCORPORATING RH-WMA ADDITIVE**

by

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**Thesis submitted in fulfillment of the
requirements for the Degree
of Doctor of Philosophy**

April 2017

ACKNOWLEDGEMENTS

In the name of Allah, the most beneficent, the most merciful

I would like to express my utmost sincere thanks to my supervisor, Professor ***Meor Othman bin Hamzah*** for his endless guidance, motivation and supports. Thank you for always providing me hope and encouragement during my hard times. I am most grateful for that. He has supported me financially since the first day.

Thanks to my co-supervisor, Dr. Babak Golchin for his guidance, suggestions and willingness to help me in any way he can. I am also indebted to the technicians of Highway Engineering Laboratory, Universiti Sains Malaysia, Mr. Mohd Fouzi bin Ali and Mr. Zulhairi bin Ariffin. I am also indebted to the technician of Structural Engineering Laboratory, Mr. Abdolah Md Nanyan and technician of Polymer Research Laboratory, School of Materials and Mineral Resources Engineering, Mr. Muhammad Sofi bin Jamil, for their excellent support, co-operation and guidance throughout my laboratory works. Special thanks to my brother Professor Muktar whom I regard as my father. My appreciation also goes to Universiti Sains Malaysia for providing me with the laboratory facilities and financial supports. My thanks also go to Dr. Ali Jamshidi and all my friends in the Highway Engineering Laboratory. I am also grateful to Dr. Muhammad Rafiq Kakar, Mr. Foad AlKute, Mdm. Lilian Gungat and Mdm. Noor Halizah binti Abdullah. A special thanks to Mr. Teh Sek Yee for helping me to write this thesis. This thesis is dedicated to all Malaysians because of their hospitality during my stay in this country. I hope this thesis could be considered as a small step taken in sustainable development for greener future of our globe.

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LIST OF ABBREVIATIONS

A	Aging
AASHTO	American Association of State Highway and Transportation Officials
AC	Aging Condition
AI	Aging Index
ANOVA	Analysis of Variance
APA	Asphalt Pavement Analyzer
ASTM	American Society for Testing and Material
BBR	Bending Beam Rheometer
BBS	Asphalt Binder Bond Strength
CEI	Compaction Energy Index
CGN	Compaction Gyrations Number
PC	Percentage Change
CS	Creep Stiffness
DSR	Dynamic Shear Rheometer
DTT	Direct Tensile Tester
GHG	Greenhouse Gas
GLM	General Linear Model
HMA	Hot Mix Asphalt
HWTT	Hamburg Wheel Tracking Test
ITS	Indirect Tensile Strength
LTA	Long-Term-Aging
MT	Mixing Temperature

OAC	Optimum Asphalt Content
PATTI	Pneumatic Adhesion Tensile Testing Instrument
PAV	Pressure Aging Vessel
PG	Performance Grade
PMB	Polymer-Modified -Binder
PMD	Pavement Modifier
PWD	Public Work Department
RAP	Reclaimed Asphalt Pavement
RAS	Recycled Asphalt Shingle
RH	RH-WMA
RSM	Response Surface Methodology
RTFO	Rolling Thin Film Oven
RV	Rotational Viscometer
SBR	Styrene-Butadiene-Rubber
SBS	Styrene-Butadiene-Styrene
SMA	Stone Mastic Asphalt
STA	Short-Term-Aging
TDI	Traffic Densifications Index
TSR	Tensile Strength Ratio
TT	Test Temperature
UTM	Universal Testing Machine
VAI	Viscosity Aging Index
VFA	Voids in Filled Asphalt
VMA	Voids Mineral Aggregate

VOC	Volatile Organic Compounds
VTM	Voids in Total Mixture
WMA	Warm Mix Asphalt

LIST OF SYMBOLS

G_{mb}	Bulk Specific Gravity
G^*	Dynamic Modulus
G'	Elastic Component or Storage Modulus
Na_2CO_3	Sodium Carbonate
$G^*/\sin \delta$	Superpave™ Rutting Factor
$G^*\sin \delta$	Superpave™ Fatigue Factor
G_{mm}	Theoretical Maximum Density
G''	Viscous Component or Loss Modulus
δ	Phase Angle

**KESAN PENGUSIAAN, SUHU, AGREGAT LEMBAP DAN JENIS FILLER
KE ATAS PRESTASI CAMPURAN ASFALT SUAM YANG
MENGANDUNGI BAHAN TAMBAH RH-WMA**

ABSTRAK

Campuran asphalt panas (HMA) telah menjadi bahan utama yang digunakan di dalam turapan sejak beberapa dekad yang lalu. Sejak kebelakangan ini, berbanding campuran HMA konvensional, campuran asphalt suam (WMA) telah menunjukkan potensi yang besar dan ber manfaat tidak dapat diperolehi daripada campuran HMA, kerana campuran WMA boleh dihasilkan pada suhu yang lebih rendah tanpa memberi kesan kepada prestasi turapan. Bahan tambah WMA boleh mengurangkan kelikatan pengikat. Oleh itu, suhu pengeluaran dan pemadatan adalah lebih rendah berbanding campuran HMA konvensional. Salah satu bahan tambah yang digunakan untuk menghasilkan WMA adalah sejenis lilin yang dinamakan sebagai RH-WMA. Di dalam tesis ini, ciri-ciri reologi asphalt PG64 dengan dan tanpa RH-WMA pada keadaan penuaan yang berbeza telah dikaji. Secara keseluruhan, keputusan ujian reologi pengikat menunjukkan bahawa kandungan RH-WMA telah memberi kesan yang signifikan terhadap parameter reologi asphalt pengikat dari segi kelikatan, $G^*/\sin \delta$ dan $G^*\sin \delta$. Teknik analisis imej telah digunakan untuk mengelaskan kegagalan perekatan dengan menggunakan ujian hentaman. Ujian hentaman telah dijalankan terhadap acuan baru yang telah direka khas dan kesan keadaan penuaan dan suhu ujian asphalt pengikat dengan RH-WMA telah dikaji. Analisis keputusan menunjukkan bahawa penuaan jangka masa pendek dan panjang asphalt pengikat telah meningkatkan kegagalan rekatan. Suhu pembinaan (campuran dan pemadatan) telah dikurangkan dengan penambahan bahan tambah RH-WMA yang menyebabkan penurunan kadar